## GROUP 54B

# LOCAL INTERCONNECT NETWORK (LIN)

CONTENTS

# GENERAL DESCRIPTION

M2543000100011

LIN refers to "Local Interconnect Network", a global standard of serial multiplex communication protocol*1 administrated by LIN consortium. A communication circuit employing the LIN protocol connects each ECU, and switch data can be shared among ECUs, which enables more reduction in wiring. Transmission speed is 19.2 kbps.

For COLT, ETACS*2-ECU can receive some input signals through CAN*3 communication in addition to the LIN communication.

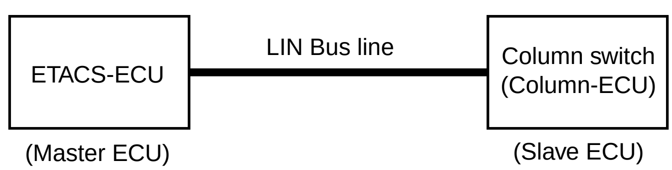
*NOTE: *1: The regulations have been decided in detail, from software matters such as the necessary transmission rate for communication, the system, data format, and communication timing control method to hardware matters such as the harness type and length and the resistance values.*

*NOTE: *2: ETACS (Electronic Time and Alarm Control System)*

*NOTE: *3: CAN (Controller Area Network)*

# STRUCTURE

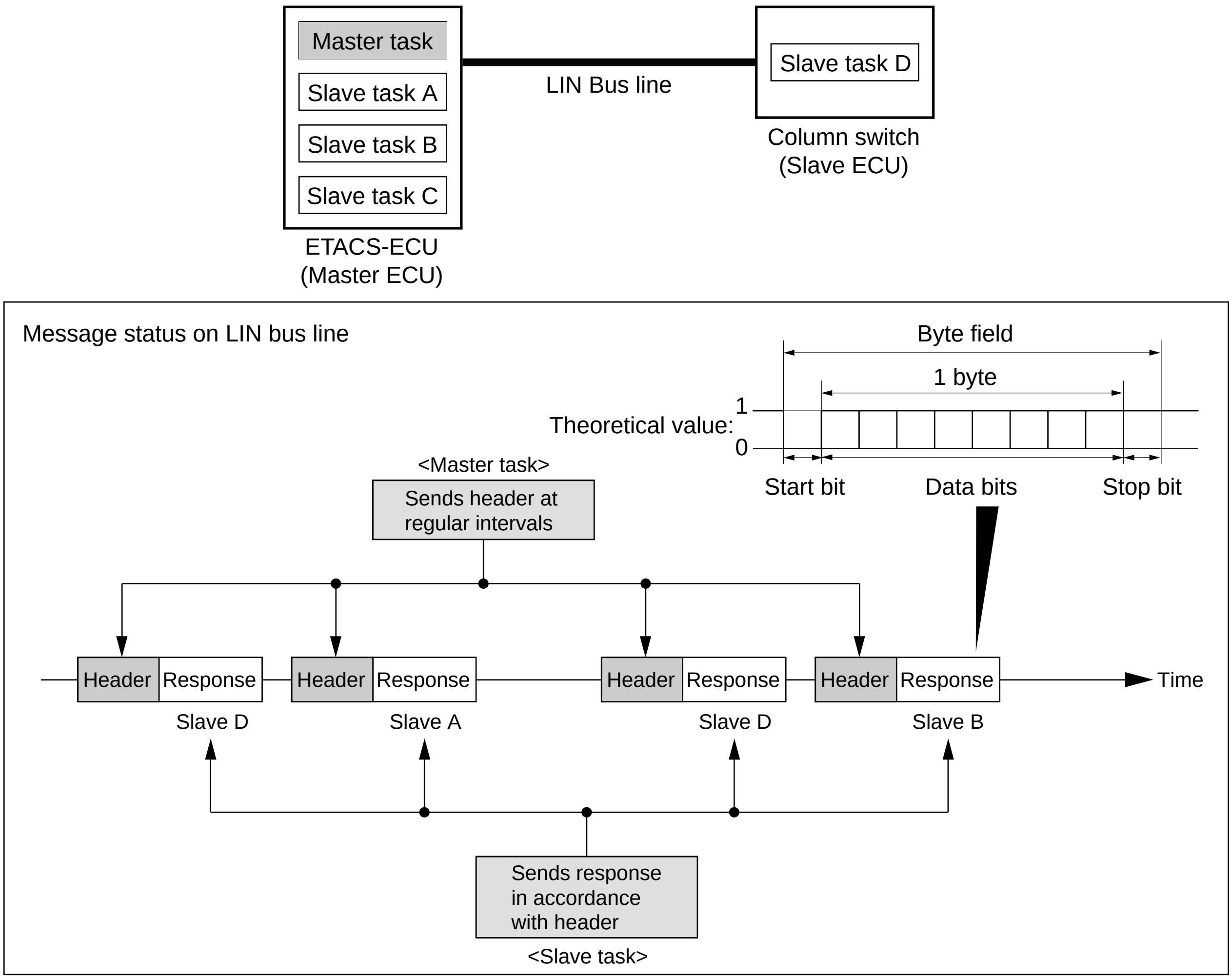
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ETACS-ECU and column switch (column-ECU) are connected to a LIN bus line. For COLT, ETACS-ECU works as a master ECU (main ECU), and the column switch (column-ECU) works as a slave ECU (subordinate ECU) to establish communication.

# SYSTEM OPERATION

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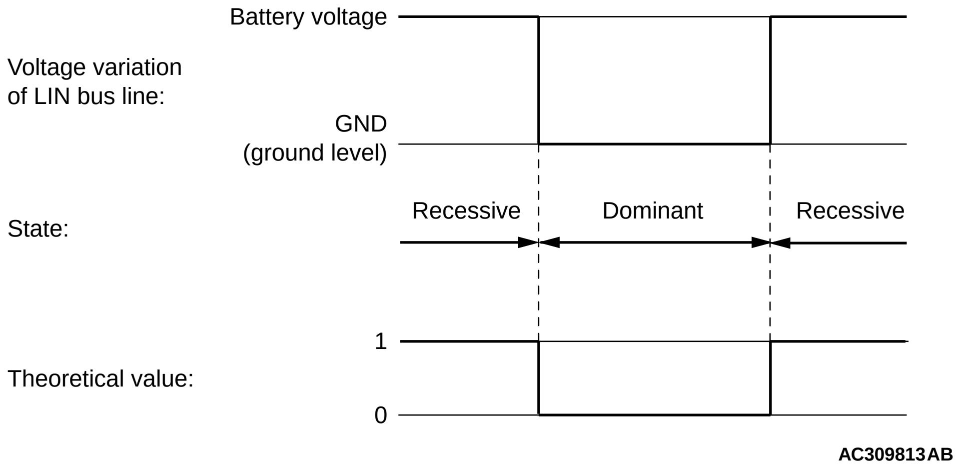



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LIN communication system is described below.

- ETACS-ECU (master ECU) performs a leading task (master task), and the column-ECU (slave ECU) operates by responding to the master task (slave task).
- When the master ECU performs a master task, the header frame which stores information required to call a certain slave task (ECU) is transmitted at regular intervals.
- When the slave ECU or master ECU performs a slave task, ECU called by the header frame transmits the response frame which stores data used for control.
- Basically, communication data is used with some blocks of 10-bit data group known as "byte field" (including one start bit and one stop bit for each block) stored in order.
- Both header and response frames are processed as a group and usually referred to as "Message Frame." For further details, consult the message frame section P.54B-3.
- A communication method using message frames is known as "Frame Communication."
- Higher reliability is secured by various kinds of error detection functions. For further details, consult the error detection function section P.54B-3.
- For further details on the main communication signals, refer to P.54B-6.

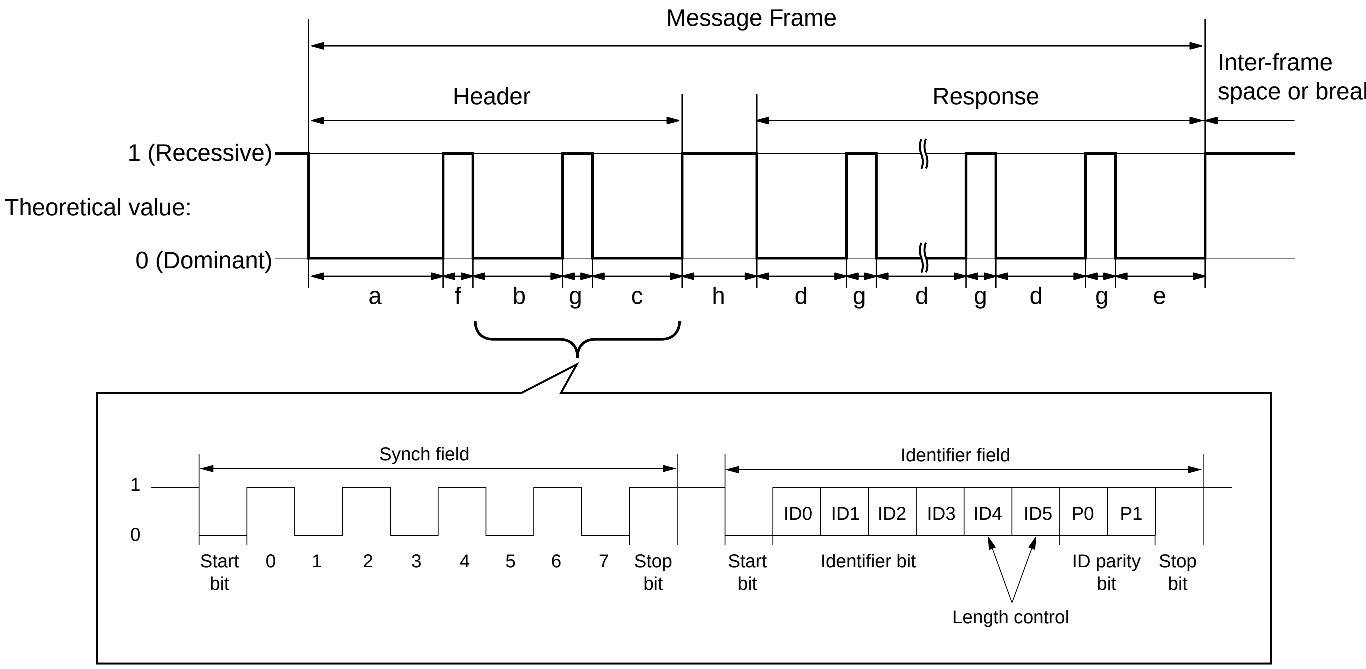
## VOLTAGE VARIATION OF LIN BUS LINE




When ECU sends or receives signals, LIN bus line voltage varies as follows.

- The voltage variation of LIN bus line (0 and 1 combination as a theoretical value) ranging between battery voltage (recessive) and 0 V (dominant) is output (transmitted) as a control signal.
- When no communication is established, the LIN bus line remains recessive (battery voltage).

## MESSAGE FRAME




a: Synch break
b: Synch field
c: Identifier field
d: Data field
e: Checksum field
f: Synch break delimiter
g: Interbyte space
h: In-frame response space

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A message frame consists of synch break, synch field, identifier field, data field, checksum field, synch break delimiter, and in-frame response space. Maximum message frame length is determined according to the number of bytes of the data field.

| Frame | Field name | | Description | Length |
|---|---|---|---|---|
| Header | a | Synch Break | A field for informing each ECU of the starting of header transmission by sending dominant for a given period of time | 13 bits or more (Synch Break does not include start bit and stop bit). |
| | b | Synch Field | A field for synchronizing transmission cycle of each ECU connected to LIN bus line (The transmission speed of the slave ECU is synchronized with that of the master ECU). | 1 byte + 2 bit (start bit and stop bit) |
| | c | Identifier Field | A field for ID defined by LIN protocol. The number of bytes for data field is also defined in this field. | 1 byte + 2 bit (start bit and stop bit) |
| Response | d | Data Field | A field for storing ECU control data called by the header frame | Either 2 byte + 4 bit, 4 byte + 8 bit, or 8 byte + 16 bit (Start bit and stop bit (2 bits) are added in every 1 byte). |
| | e | Checksum Field | A field for checking errors in data content The sending-end ECU calculates data field value according to the specified computing equation, and the result is stored in this field. The receiving-end ECU detects transmission error by comparing data in checksum field and data field. | 1 byte + 2 bit (start bit and stop bit) |

*NOTE: Synch break delimiter, interbyte space, and in-frame response space fields are the ones for detecting a start bit of a next field.*

## ERROR DETECTION

By introducing checksum field into the message frame and integrating various kinds of error detection functions into the master and slave ECUs, the LIN protocol has assured higher communication reliability.

# LIN COMMUNICATION SIGNAL TABLE

M2543000400012

| Signal | Transmitter ECU | Receiver ECU | |
|---|---|---|---|
| | | Column switch | ETACS-ECU |
| Master sleep request signal | ETACS-ECU | × | – |
| Tail lamp switch signal | Column switch | – | × |
| Headlamp (low beam) switch signal | | – | × |
| Headlamp (high beam) switch signal | | – | × |
| Turn signal lamp (LH) switch signal | | – | × |
| Turn signal lamp (RH) switch signal | | – | × |
| Headlamp washer switch signal | | – | × |
| Passing switch signal | | – | × |
| Windshield intermittent wiper switch signal | | – | × |
| Windshield low-speed wiper switch signal | | – | × |
| Windshield high-speed wiper switch signal | | – | × |
| Windshield washer switch signal | | – | × |
| Rear wiper switch signal | | – | × |
| Rear washer switch signal | | – | × |
| Windshield mist wiper switch signal | | – | × |
| Intermittent wiper interval adjusting knob signal | | – | × |

# DIAGNOSIS CODE TABLE

M2543000500019

| Code No. | Diagnostic item | |
|---|---|---|
| B1720 | Dead keyless entry transmitter battery | |
| B1728 | Abnormal voltage at ETACS-ECU power supply | |
| B1729 | | |
| B1721 | Immobilizer | Base station failure |
| B1722 | | Antenna failure |
| B1723 | | Transponder communication failure |
| B1725 | | Wrong data/random number in CAN message |
| B1726 | | Too much challenges received |
| B1730 | | Key out of sync |
| B1731 | | Immobilizer communication failure |
| B1740 | Flasher timer | Blown turn signal lamp (RH) bulb |
| B1741 | | Blown turn signal lamp (LH) bulb |
| B1742 | | Turn signal lamp switch failure |
| B1743 | | Blown hazard warning lamp fuse |
| B1744 | | Hazard warning lamp switch failure |

| Code No. | Diagnostic item | |
|---|---|---|
| B1760 | Variant cording not completed | |
| B1761 | VIN data not entered | |
| U1073 | CAN communication | Bus Off |
| U1100 | | Engine-ECU <M/T> or A-M/T-ECU* <Automated manual transmission> time-out (related to engine) |
| U1101 | | Engine-transmission-ECU time-out (related to automated manual transmission) |
| U1102 | | ABS or active stability control system-ECU time-out |
| U1108 | | Combination meter time-out |
| U1111 | | Multi-centre display unit (middle-grade type) time-out |
| U1112 | | SRS-ECU time-out |
| U1121 | | Failure information on A-M/T-ECU* (related to automated manual transmission) |
| U1128 | | Failure information on combination meter |
| U1500 | LIN communication | Column switch time-out |
| U1507 | | EATCS-ECU transmission error |

*NOTE: *: Engine automated manual transmission electronic control unit*

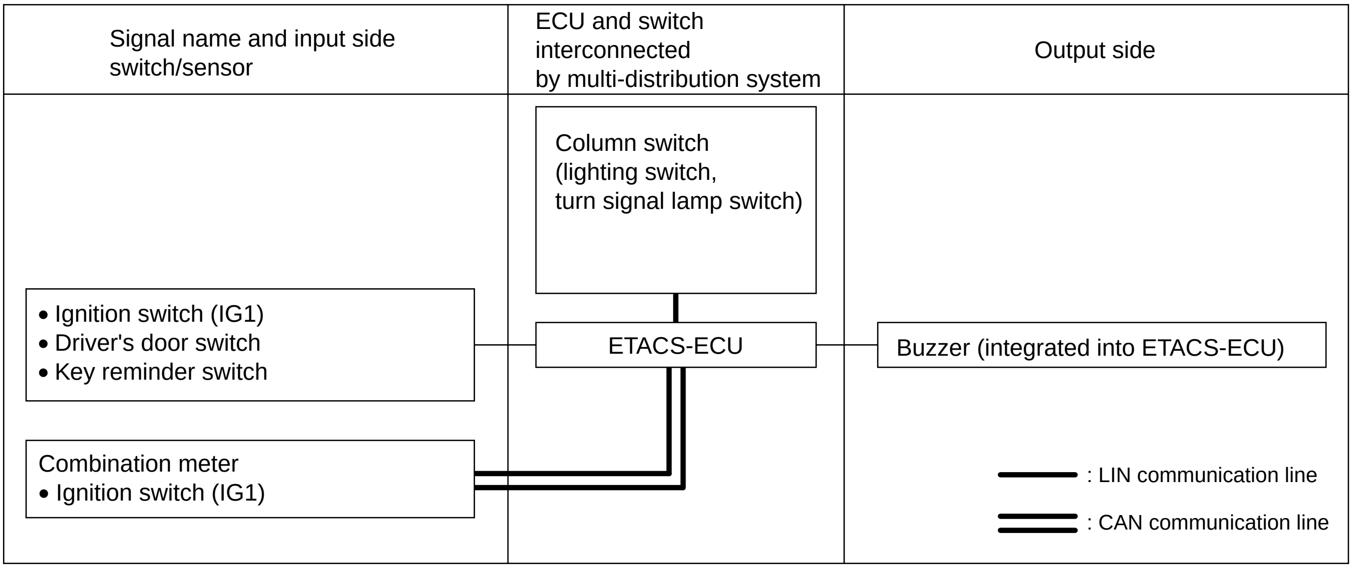
# MULTI-DISTRIBUTION INPUT/OUTPUT BY CIRCUIT

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The multi-distribution system is adopted in the following circuit. The following circuit diagram shows input switches, input sensors, and correlation of ECUs interconnected via multi-distribution line buses.

**Buzzer**

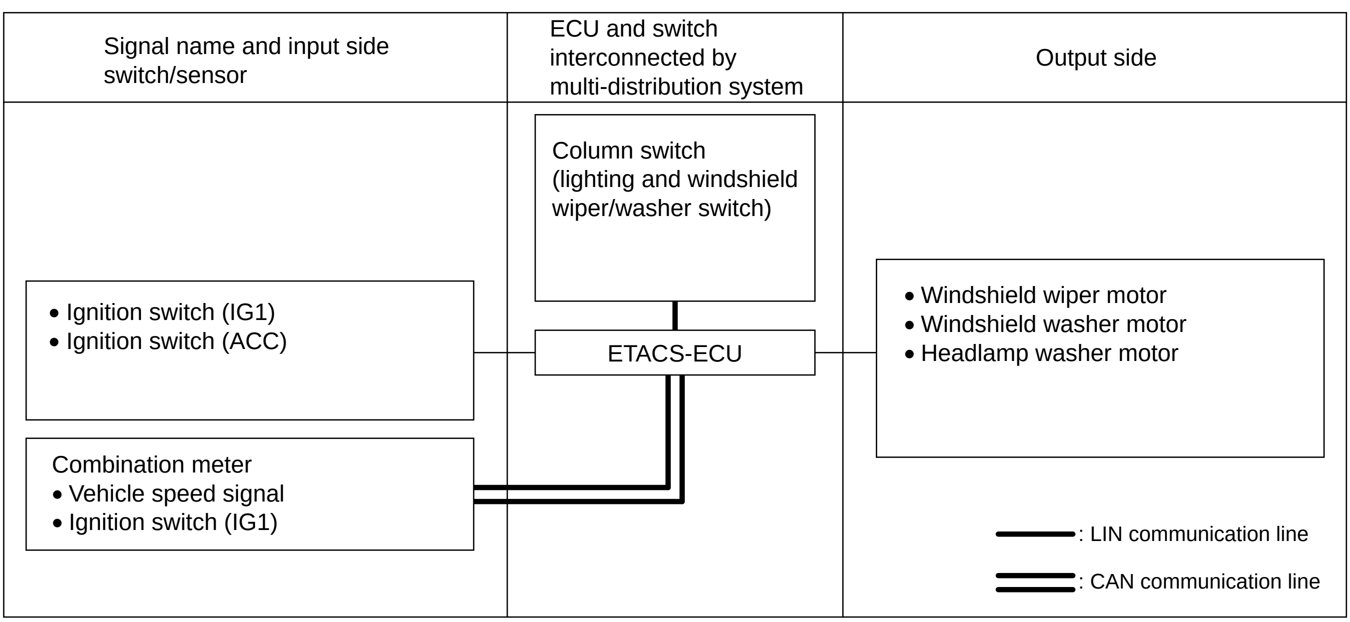
- Lamp reminder function
- Turn-signal lamp operation sound function




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### Windshield wiper/washer

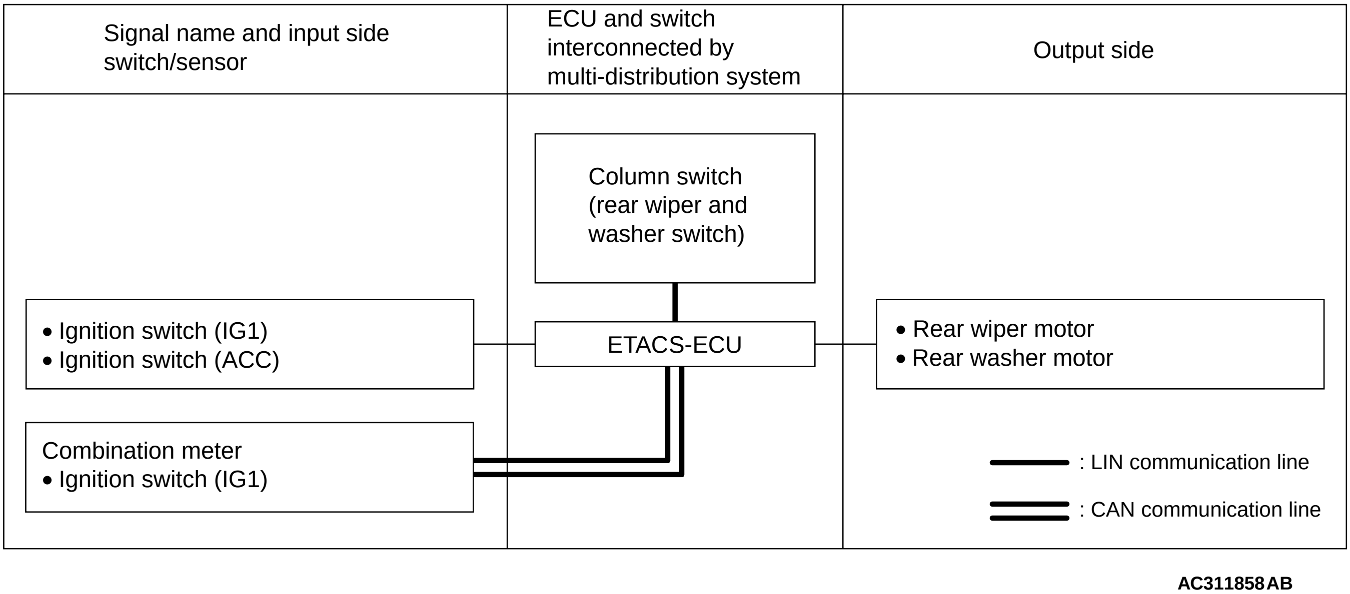
- Intermittent control (vehicle speed sensing intermittent time adjustable type)
- Mist wiper control
- Low speed wiper and high speed wiper control
- Windshield wiper linked with washer function
- Headlamp washer control




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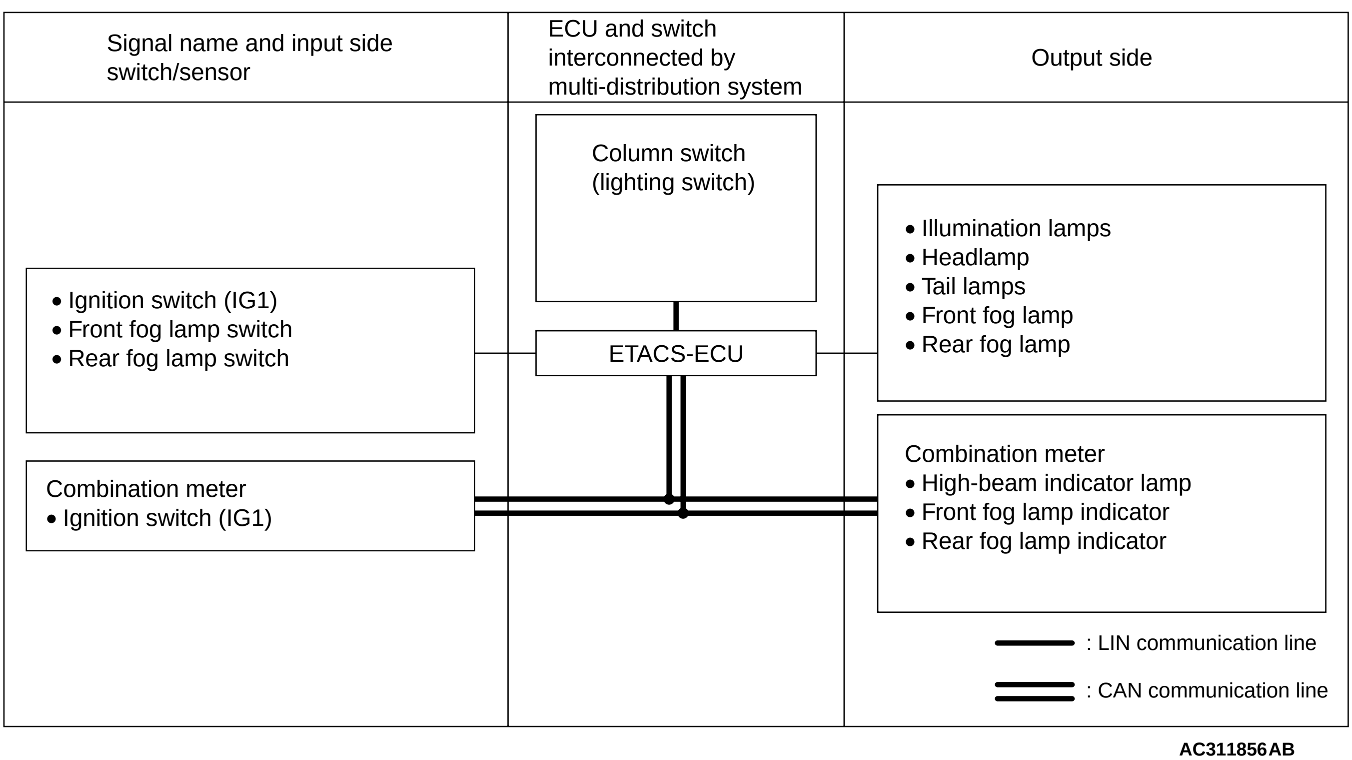
### Rear wiper/washer

- Rear wiper control
- Rear wiper linked with washer function



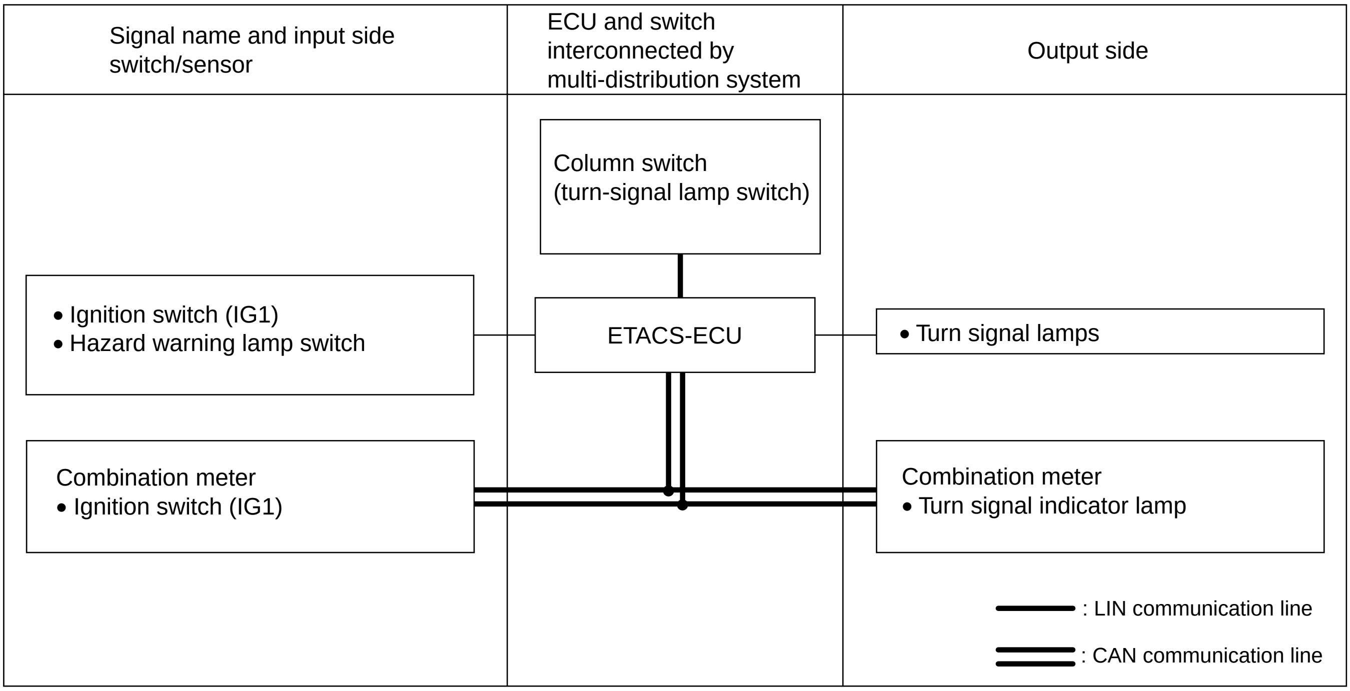

## Lighting

- High-beam indicator
- Daytime running lamp <Vehicle with daytime running lamp>
- Front fog lamp control
- Front fog lamp indicator
- Rear fog lamp control
- Rear fog lamp indicator




## Flasher timer function

- Turn-signal lamp control
- Comfort flashing function
- Turn signal lamp indicator
- Hazard warning lamp




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# INPUT SIGNAL TABLE

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## INPUT SIGNAL CHECK USING MUT-III

Every switch operation can be examined by connecting the MUT-III to the diagnostic connector and operating the switches whose signals are input to the ETACS.

For the details of the input signal check, refer to the Workshop Manual.

### DIAGNOSABLE INPUT SIGNALS

| Input signals | | Check conditions |
|---|---|---|
| LIN communication signal | Column switch | When the column switch (lighting, wiper switch) is operated |

| Input signals | | Check conditions |
|---|---|---|
| Digital signals | Ignition switch (ACC) | When the ignition switch is turned from LOCK (OFF) to ON |
| | Ignition switch (IG1) | When the ignition switch is turned from ACC to ON position |
| | Hazard warning lamp switch | When the switch is turned from OFF (not operated) to ON (operated) |
| | Front fog lamp switch | |
| | Rear fog lamp switch | |
| | Driver's door switch | When the driver's door is opened from the closed position |
| | Windshield wiper auto stop signal | When activated from the stopped condition |
| Analog signals | Battery voltage (IG1) | Voltage applied to the ETACS-ECU (IG1) can be verified. |
| | Battery voltage (battery) | Voltage applied to the ETACS-ECU (battery) can be verified. |

# ACTUATOR TEST TABLE

M2543001000017

The following actuator tests can be performed using MUT-III.

| Items | Contents |
|---|---|
| Tail lamp | Illuminates the tail lamp. |
| Headlamp low | Illuminates the headlamp low-beam. |
| Headlamp high | Illuminates the headlamp high-beam. |
| Front wiper enable | Operates the windshield wiper for 30 seconds. |
| Front wiper speed | Switches the windshield wiper speed. |
| Front washer | Operates the windshield washer for 30 seconds. |
| Rear wiper | Operates the rear wiper for 30 seconds. |
| Rear washer | Operates the rear washer for 30 seconds. |
| Headlamp washer | Operates the headlamp washer. |
| DRL tail output | Activates the daytime running lamp function (Illuminates the low-beam). |
| Front fog lamp | Illuminates the front fog lamp. |
| Rear fog lamp | Illuminates the rear fog lamp. |
| Turn lamp (LH) | Illuminates the turn signal lamp (LH). |
| Turn lamp (RH) | Illuminates the turn signal lamp (RH). |

# FUNCTION AND CONTROL BY ECUS OF LIN

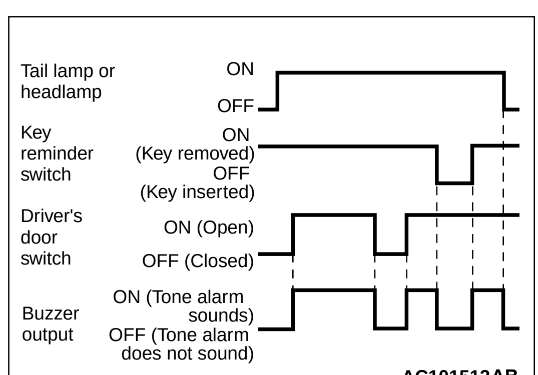
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Following functions are controlled by ECUs of LIN.

| Function | | Control ECU | Explanation of function |
|---|---|---|---|
| Buzzer | Lamp reminder function | ETACS-ECU, column switch | P.54B-12 |
| | Turn-signal lamp operation sound function | | P.54B-13 |
| Windshield wiper/washer | Intermittent control (vehicle speed sensing intermittent time adjustable type) | ETACS-ECU, column switch | P.54B-13 |
| | Mist wiper control | | P.54B-14 |
| | Low speed wiper and high speed wiper control | | P.54B-14 |
| | Windshield wiper linked with washer function | | P.54B-15 |
| Rear wiper/washer | Rear wiper control | ETACS-ECU, column switch | P.54B-15 |
| | Rear wiper linked with washer function | | P.54B-16 |
| Headlamp washer | Headlamp washer control | ETACS-ECU, column switch | P.54B-16 |
| Headlamp | High-beam indicator | ETACS-ECU, column switch | P.54B-16 |
| | Daytime running lamp | | P.54B-17 |
| Flasher timer function | Turn-signal lamp control | ETACS-ECU, column switch | P.54B-17 |
| | Comfort flashing function | | P.54B-17 |
| | Turn-signal lamp indicator | | P.54B-17 |
| | Hazard warning lamp control | | P.54B-17 |
| Front fog lamp | Front fog lamp control | ETACS-ECU, column switch | P.54B-18 |
| | Front fog lamp indicator | | P.54B-18 |
| Rear fog lamp | Rear fog lamp control | ETACS-ECU, column switch | P.54B-18 |
| | Rear fog lamp indicator | | P.54B-18 |
| Customization function | | ETACS-ECU | P.54B-19 |

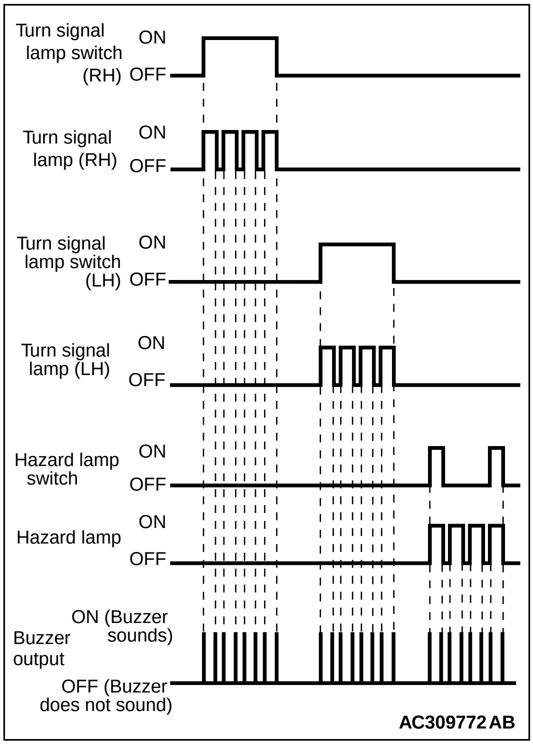
## BUZZER

### LAMP REMINDER FUNCTION



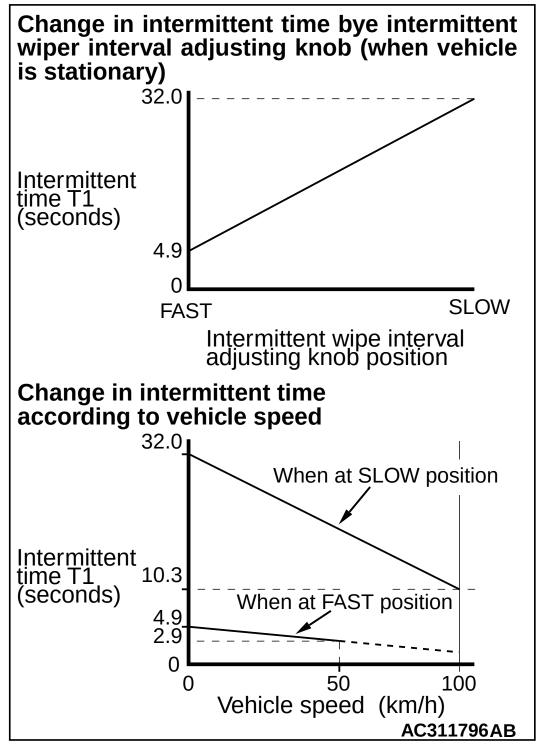
When the ignition key is removed and then the driver's door is opened with turning ON the tail lamp or the head lamp, the buzzer sounds continuously to alert the driver that the lamp is still ON.

## TURN-SIGNAL LAMP OPERATION SOUND FUNCTION



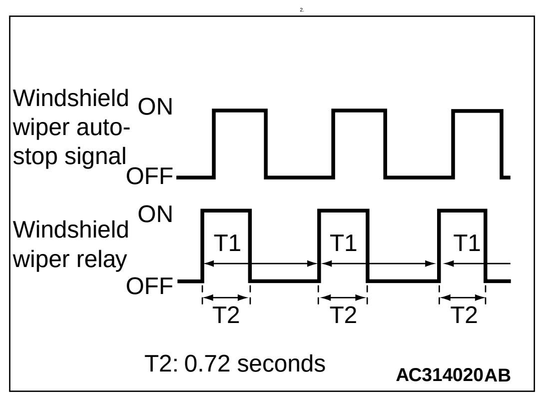

ETACS-ECU buzzer sounds simultaneously with the blinks of the turn signal lamp and the hazard lamp.

## WINDSHIELD WIPER/WASHER INTERMITTENT CONTROL (VEHICLE SPEED SENSING INTERMITTENT TIME ADJUSTABLE TYPE <THE INITIAL SETTING: WITH FUNCTION>




ETACS-ECU calculates the intermittent time T1 based on the variable intermittent wiper volume switch signal sent from the column switch, and on the vehicle speed signal sent from the combination meter through CAN communication.

*NOTE: When the variable intermittent wiper volume switch is set at FAST position, the windshield wiper continuously operates at low speed instead of operating in an intermittent mode whenever the vehicle speed exceeds 50 km/h.*

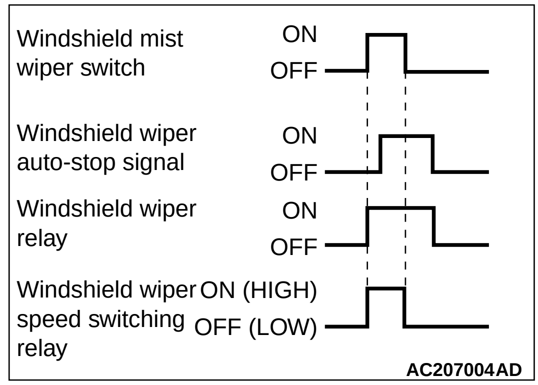


When ETACS-ECU receives the windshield intermittent wiper switch ON signal from the column switch while the ignition switch is in the ACC or ON position, it turns the windshield wiper relay ON to operate the windshield wiper at low speed.

3. When the windshield wiper comes to the stop position, the windshield wiper auto stop signal turns OFF. Then the windshield wiper relay will turn OFF, and the windshield wiper stops operating.
4. When the intermittent time T1 has elapsed after the windshield wiper relay was turned OFF, ETACS-ECU turns ON the windshield wiper relay again and repeats the above procedure.

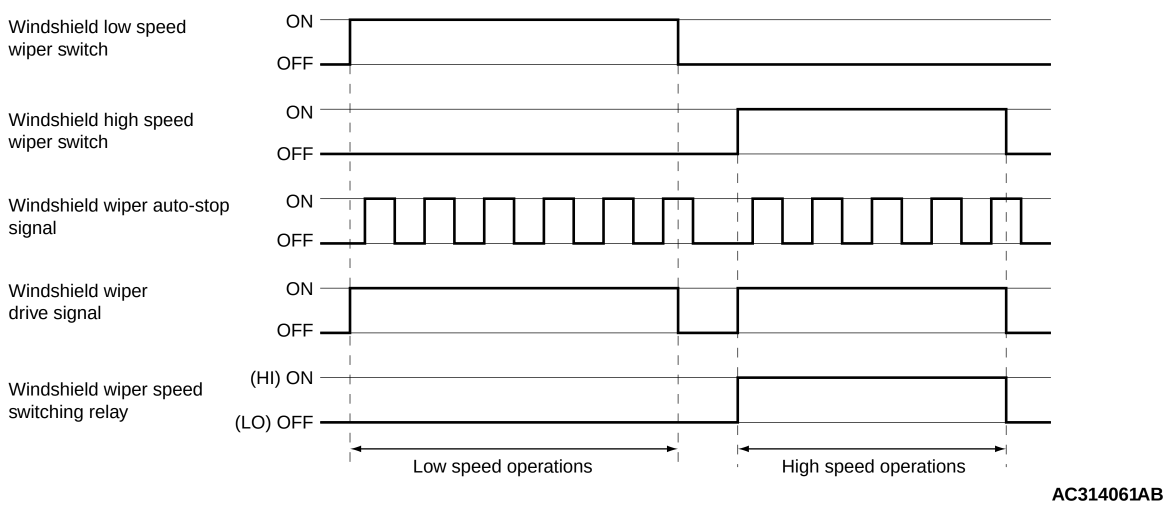
*NOTE: Using a customisation function, the calculation method of the intermittent time T1 can be configured (Refer to P.54B-19).*

## MIST WIPER CONTROL




When the windshield mist wiper switch of the column switch is turned ON with the ignition switch in the ACC or ON position, ETACS-ECU turns ON the windshield wiper drive signal. At the same time, the wiper speed switch relay turns to ON (HI). When the windshield mist wiper switch is ON, the windshield wiper operates at the high speed.

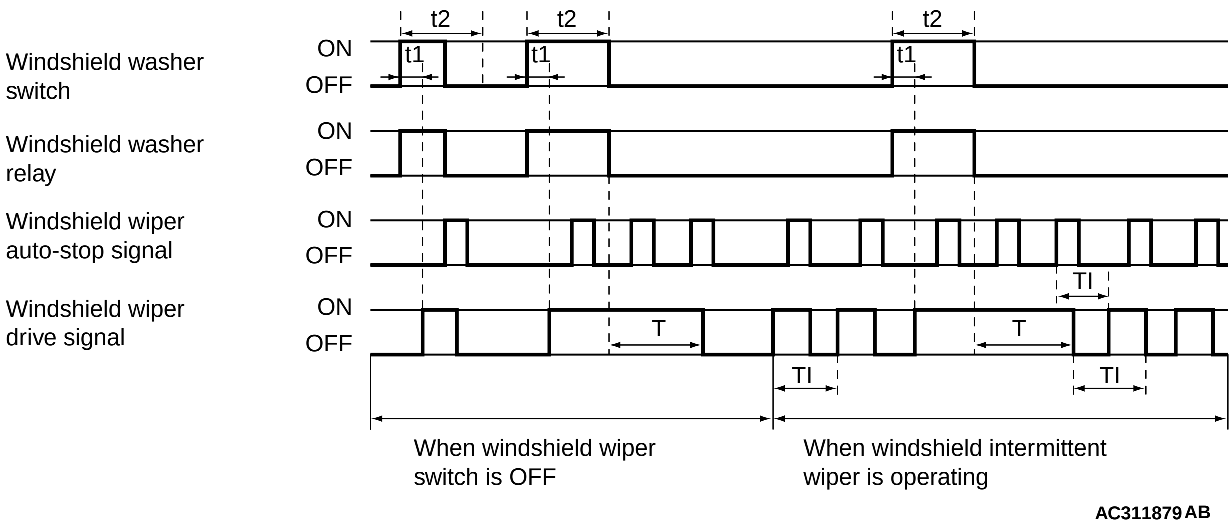
### Low speed wiper and high speed wiper control




When the windshield low speed wiper switch of the column switch is turned ON while the ignition switch is ACC or ON, the column switch turns ON the windshield wiper drive signal. Also, the wiper speed switching relay turns to OFF (LO), and the windshield wiper operates at the low speed.

When the windshield high speed wiper switch is turned ON, the windshield wiper drive signal turns ON. Also, the wiper speed switching relay turns ON (HI), and the windshield wiper operates at the high speed.

## Windshield wiper linked with washer function <Initial setting: with function>




**<When windshield wiper switch is in "OFF" or "INT" position>**

- When the windshield washer switch is turned ON for less than 0.5 seconds: the windshield wiper will be activated  0.24 seconds after the windshield washer switch has been turned ON and will operates for 1 cycle.
- When the windshield washer switch is turned ON for 0.5 seconds or more: the windshield wiper will be activated  0.24 seconds after the windshield washer switch has been turned ON and continues operating for 3 seconds after the windshield washer switch has been turned OFF.

When the windshield wiper switch is in "INT" position, the windshield will resume the intermittent operation after the windshield wiper linked with washer function has been completed.

**<When windshield wiper switch is in "LO" or "HI" position>**

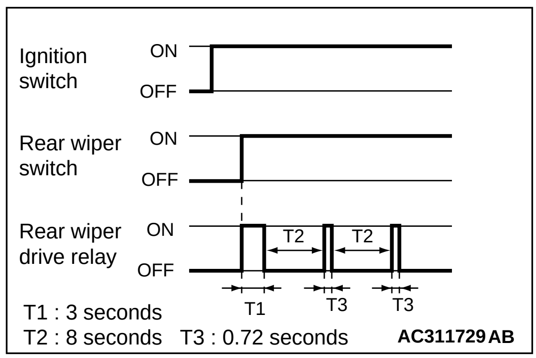
- Windshield wiper operation will be stopped for 3 seconds when the windshield washer switch is turned ON.

*NOTE:*

- *Using a customisation function, the windshield wiper linked with washer function can be enabled or disabled (Refer to P.54B-19).*
- *When the windshield wiper linked with washer function is invalidated by the customisation function, the washer operates. It is useful to melt down the ices of the frozen windshield.*

## REAR WIPER/WASHER

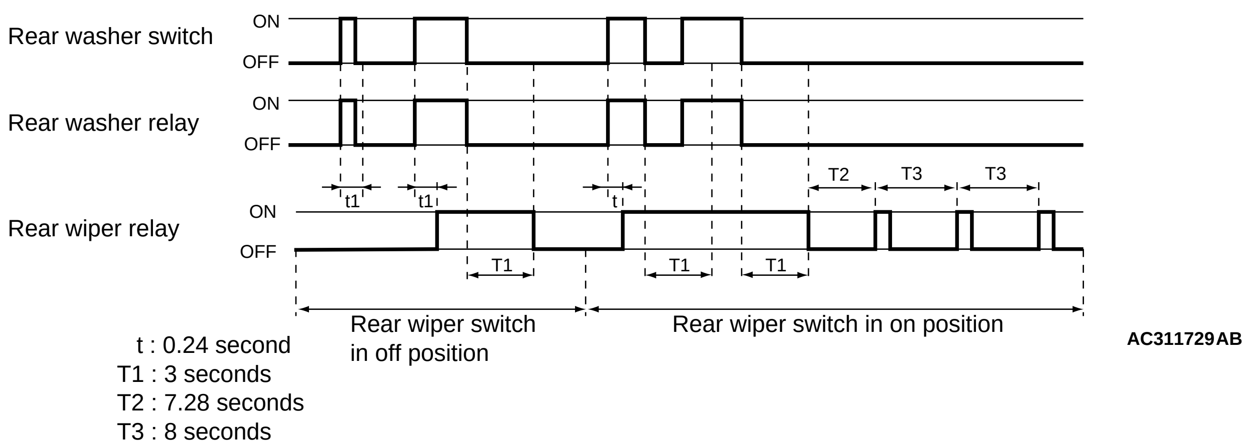
## REAR WIPER CONTROL




When the rear wiper switch on the column switch is turned ON with the ignition switch at the ACC or ON position, ETACS-ECU turns ON the rear wiper drive signal for 3 seconds (approximately 2 operations), and performs the intermittent action at 8-second intervals.

*NOTE: Using a customisation function, the rear wiper intermittent operation time can be configured (Refer to P.54B-19).*

## REAR WIPER LINKED WITH WASHER FUNCTION <INITIAL SETTING: WITH FUNCTION>



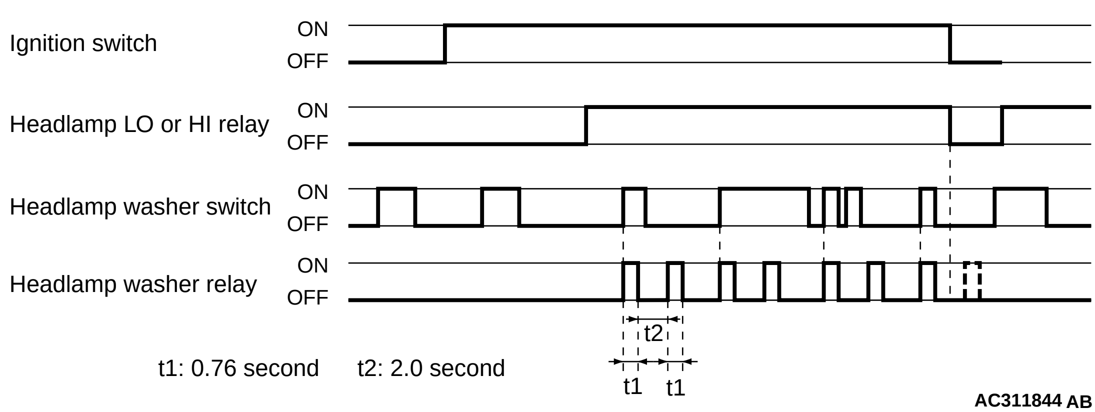

When the rear washer switch on the column switch is turned ON with the ignition switch ACC or ON, ETACS-ECU turns ON the rear washer relay.
When the rear washer switch is turned ON for 0.24 second or more, ETACS-ECU will turn ON the rear wiper drive signal and operate the rear wiper continuously. The rear wiper will stop 3 seconds after the rear washer switch has been turned OFF.

If the rear washer switch is turned ON during the rear wiper operation, the intermittent action is continued at 8-second intervals, 7.28 seconds after the rear wiper drive signal has been turned OFF.

*NOTE: Using a customisation function, the rear wiper linked with washer function can be enabled or disabled (Refer to* *P.54B-19**).*

## HEADLAMP WASHER

## HEADLAMP WASHER CONTROL




When the headlamp washer switch is turned ON while the ignition switch is in the "ON" position and the headlamp is on (either in Lo-beam or Hi-beam), the headlamp washer control turns ON the headlamp washer relay twice for 0.76 seconds in each cycle.

## HEADLAMP

## HIGH-BEAM INDICATOR

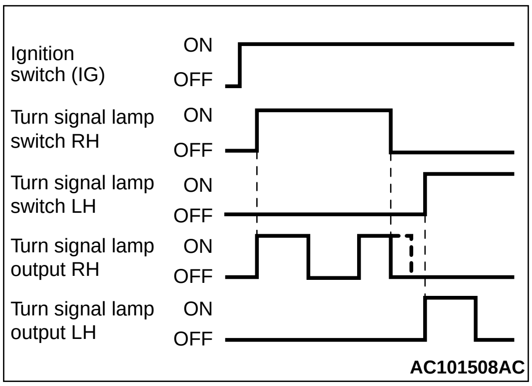
The ETACS-ECU outputs the high beam indicator ON signal to the combination meter through CAN communication in synchronization with the high beam headlamp operation. The combination meter receives the transmitted signal and turns ON or OFF the high beam indicator.

## DAYTIME RUNNING LAMP <VEHICLE WITH DAYTIME RUNNING LAMP>

When the ignition switch is turned to the "ON" position while the headlamp switch is in the "OFF" position, the ETACS-ECU illuminates the tail lamp and headlamp (Lo-beam).

## FLASHER TIMER FUNCTION

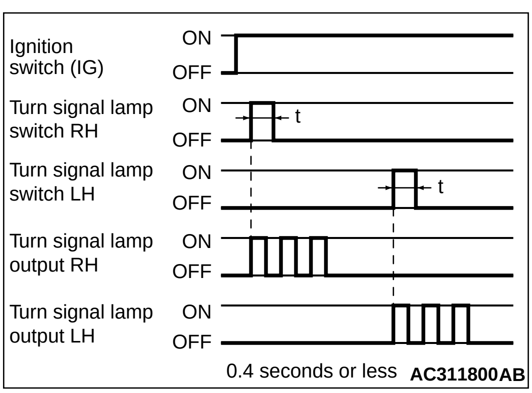
## TURN SIGNAL LAMP




When the turn signal lamp switch is ON (LH or RH) with the ignition switch ON, the turn signal lamp output (flash signal) is turned ON.

If the lamp bulb of the front or rear turn signal lamp has burned out, the flashing speed becomes faster to alert the driver that the lamp bulb has burned out.

## COMFORT FLASHING FUNCTION <INITIAL CONDITION: WITH FUNCTION>



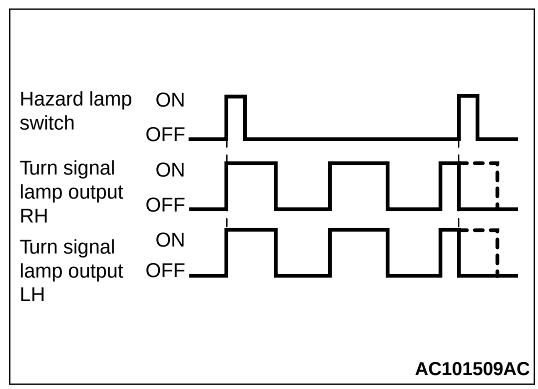

When the turn signal lamp switch is turned ON momentarily (0.4 seconds or less) while the ignition switch is in the "ON" position, the turn signal lamp (selected side) flashes 3 times.

*NOTE: Using a customisation function, the comfort flashing function can be enabled or disabled, and the operating conditions of the function and flashing pattern of the turn signal lamp can be configured (Refer to P.54B-19).*

## TURN-SIGNAL LAMP INDICATOR

ETACS-ECU outputs the turn signal lamp indicator ON signal through CAN communication in synchronization with the turn signal lamp illumination. The combination meter receives the transmitted signal and turns ON or OFF the turn signal lamp indicator.

## HAZARD WARNING LAMP CONTROL



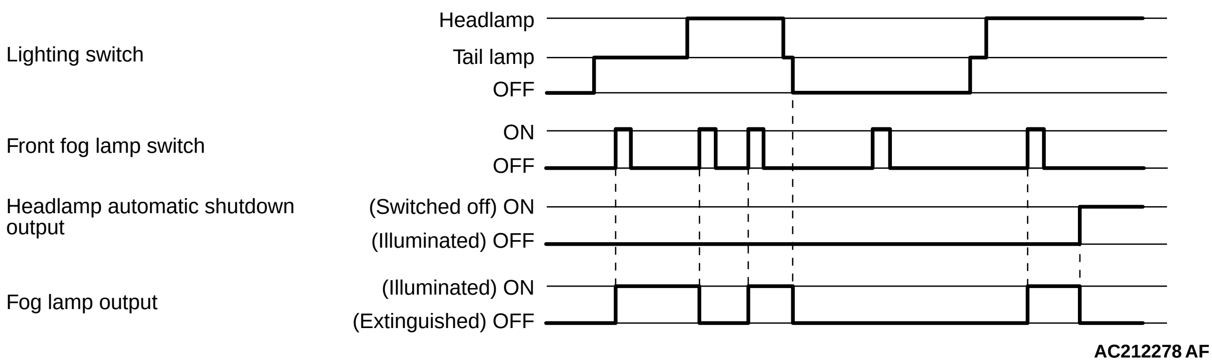

When the hazard lamp switch input signal turning from OFF to ON is detected, the flashing states turns over by the signal (When the hazard lamp is not blinking, it blinks. If it is blinking, it turns off).

*NOTE:*

1. *The push-return switch is adopted for the hazard lamp switch.*
2. *Even if the lamp bulb has burned out, the flashing speed of the hazard lamp is not changed.*

# FRONT FOG LAMP

## FRONT FOG LAMP CONTROL



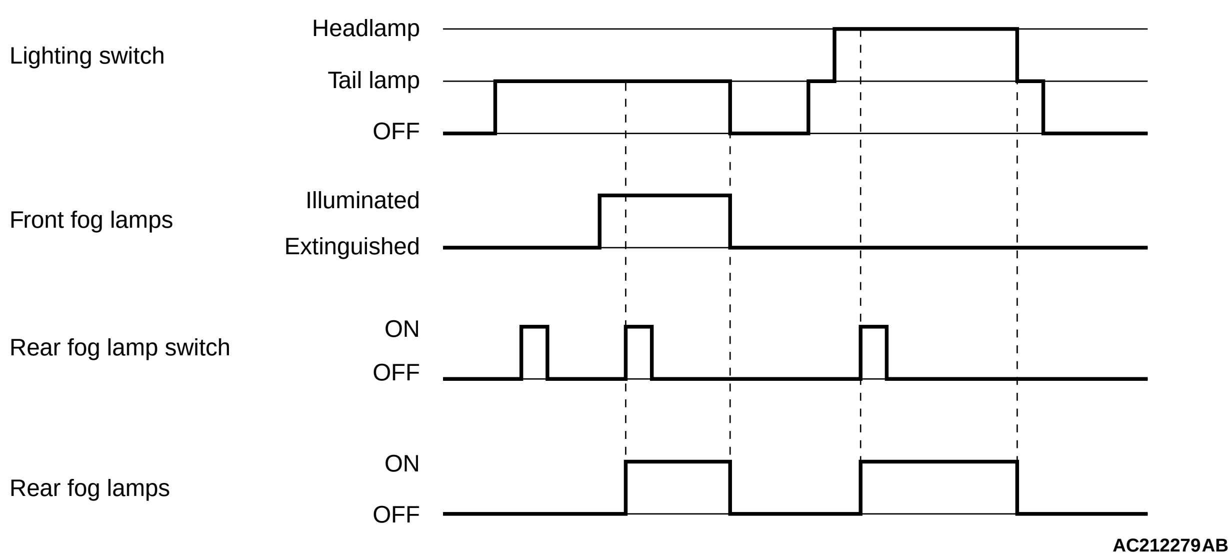

When the fog lamp switch is turned to ON with the tail lamp or the headlamp lit (the tail lamp switch or the headlamp switch is ON), the fog lamp relay turns ON, and the fog lamps turn on.
If the tail lamp or the headlamp is turned off with the lighting switch OFF while the fog lamps lit, the fog lamps turn off the same time to prevent unattended operation.
If the tail lamp is turned off by the headlamp automatic-shutdown function, the fog lamps turn off at the same time. However, if the tail lamps turn on again, the fog lamps do not.

## FRONT FOG LAMP INDICATOR

ETACS-ECU outputs the front fog lamp indicator ON signal to the combination meter through CAN communication in synchronization with the front fog lamp illumination. The combination meter receives the signal sent from ETACS-ECU and turns the front fog lamp indicator ON and OFF.

# REAR FOG LAMP

## REAR FOG LAMP CONTROL




If the rear fog lamp switch is turned ON when the headlamp or the front fog lamp is turned ON, the rear fog lamp is switched ON and OFF alternatively.
If the headlamp and the front fog lamp are turned OFF, the rear fog lamp is turned OFF at the same time.

## REAR FOG LAMP INDICATOR

ETACS-ECU outputs the turn signal lamp indicator ON signal through CAN communication in synchronization with the turn signal lamp operation. The combination meter receives the transmitted signal and turns ON or OFF the rear fog lamp indicator.

# CUSTOMIZATION FUNCTION

M2543000700013

The following functions can be customised using MUT-III.

| Function | | Configuration |
|---|---|---|
| Tail lamp | Tail lamp operation with ignition switch in "LOCK (OFF)" position | 1: Tail lamp will not illuminate when ignition switch is in "LOCK (OFF)" position.<br>0: Tail lamp will illuminate when ignition switch is in "LOCK (OFF)" position. (Initial setting) |
| Comfort flashing function | With/without function | 1: With function (Initial setting)<br>0: Without function |
| | Flashing time | 1 – 8 times (Initial setting: 3 times) |
| | Activation condition (Turn signal lamp switch ON duration) | 0.1 – 1.0 seconds (Initial setting: 0.4 seconds) |
| | Turn signal lamp switch OFF filter (to prevent comfort flashing function from being activated by mistake when the turn signal lamp switch is turned OFF during turn signal lamp illumination) | 0 – 0.3 seconds (Initial setting: 0 second) |

| Function | | Configuration | |
|---|---|---|---|
| Windshield wiper | Intermittent control (Calculation method of intermittent operation duration) | Vehicle speed condition | 0 – 3: Operation duration will not be influenced by the vehicle speed (Influenced only by the intermittent wiper interval adjusting knob position).<br>0: 32.0 (slow) – 4.9 (fast) seconds<br>1: 27.0 (slow) – 2.9 (fast) seconds<br>2: 16.8 (slow) – Low speed operation (fast) seconds<br>3: – Low speed operation (fast) seconds<br>4: Operation duration is influenced by the vehicle speed (Initial setting). |
| | | Intermittent wiper interval adjusting knob condition | 0: Operation duration is influenced by the intermittent wiper interval adjusting knob position (Initial setting).<br>1 – 5: Operation duration will not be influenced by the intermittent wiper interval adjusting knob position (Influenced only by the vehicle speed).<br>1: 32.0 (0 k/m) – 10.3 (100 k/m) seconds<br>2: 26.0 (0 k/m) – 5.9 (100 k/m) seconds<br>3: 14.9 (0 k/m) – 3.4 (100 k/m) seconds<br>4: 8.5 (0 k/m) – Low speed operation (100 k/m) seconds<br>5: 4.9 (0 k/m) – Low speed operation (100 k/m) seconds |
| Windshield wiper linked with windshield washer function/rear wiper linked with rear washer function | With/without function | 1: With function (Initial setting)<br>0: Without function | |
| Rear wiper | Intermittent operation duration | 3 – 17 seconds or continuous operation (Initial setting: 8 seconds) | |